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Equity in online learning

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Abstract

Online learning outcomes have indicated both a gap between online and face-to-face learning and the amplification of this gap for low-income and minority learners. Evidence from studies across K–16 reveals equity issues regarding access to online courses; student attendance and achievement; and, most recently, the impact of the pandemic. This article uses Warschauer's conceptual framework of resources that shape digital inclusion—physical, human, and social—to conceptualize the equity concerns that arose during the pandemic-induced shift to emergency distance learning. This framework reveals equity issues across all three areas from abruptly moving millions into online learning environments without: requisite access to up-to-date computers and broadband internet access, the skills needed to succeed in less structured online classes, or teachers trained to effectively conduct classes online. Finally, we leverage Warschauer's framework to discuss ways to address these concerns and increase equity in online learning, as well as directions for research.

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In this article

learning as an alternative to face-to-face classes (U.S. Department of Education, 2021). This shift focused increased attention on the equitable (or inequitable) nature of online learning both prior to and during the pandemic when it served as the primary mode of K–16 education. In this article, we use Warschauer's (2003) framework to better conceptualize equity concerns that arose during the pandemic-induced shift to emergency remote learning, with their roots in inequities that existed prior to the pandemic. Equitable learning occurs when every learner belongs, contributes, and thrives, regardless of race/ethnicity or socio-economic status. As stated by the OECD (2018), “Equity does not mean that all students obtain equal education outcomes, but rather that differences in students’ outcomes are unrelated to their background or to economic and social circumstances over which students have no control” (p. 13).

To begin, we synthesize studies from K–16 contexts in the United States that illuminate the differences in (a) who takes online courses and why and (b) student attendance and performance. Then we discuss online learning during the pandemic, which we refer to as emergency distance learning (“EDL”) to distinguish it from online learning that was created intentionally in the online modality (Rice et al., 2020). Equity concerns arise in each instance—investigations of who took online courses and why prior to the pandemic, as well as student attendance and performance in courses both before and during the pandemic, are fraught with differences that relate to students’ socio-economic and minoritized status. Student performance gaps between online and face-to-face instruction, and amplified gaps among sub-populations such as underrepresented minorities and students with low socio-economic status, were consistently documented prior to the pandemic (Xu & Xu, 2019). We discuss these gaps in detail and look at their potential causes. Then we investigate evidence of similar gaps during the pandemic. Then we introduce Warschauer’s (2003) framework of the resources that shape digital inclusion—physical, human, and social. Drawing on theories of social inclusion, Warschauer (2003) identified the *physical resources*, including up-to-date computers and broadband internet access; *human resources*, such as the skills needed to succeed in online classes; and *social resources*, such as teachers trained to effectively conduct classes online, that shape equity, or the lack thereof, in online education. Finally, we discuss promising interventions and ways to increase equity in online learning as well as directions for research.

In order to narrow the scope of our discussion, we expressly limit ourselves to the United States educational context, focusing on elementary, secondary, and undergraduate education (K–16). Thus, we leave for another place and time a discussion of topics such as adult learning and massive open online courses (MOOCs).

discussed in this article have special concerns regarding equitable online learning, including those with disabilities (Crouse & Rice, 2018; Ortiz et al., 2020; Rice & Dykman, 2018), English learners (U.S. Department of Education, 2021), gifted students, LGBTQ+ students, and students experiencing homelessness, but require more in-depth treatment than is possible in a single article.

Research on online courses in undergraduate education

Access—who takes online courses and why?

Online learning takes many forms; students may enroll in a single course online or engage with their entire curriculum online. A total of 6.7 million college students enrolled in online courses in 2017, with 47% of them taking classes only in that medium (Ginder et al., 2018). In community colleges, almost one-third of students attempted at least one online course in the academic year of 2016–2017, and among these students, one-third were enrolled online exclusively (Department of Education, National Center for Education Statistics [NCES], n.d.). Almost every U.S. public college has offered online courses (over 97%; Xu & Xu, 2019). Students who enrolled in online courses tended to be older, employed, and commuting further when compared to their face-to-face peers (Coates et al., 2004; Dutton et al., 2019).

Online delivery provides students flexibility and convenience, cited as important by 74% of students in a 2016 survey (Xu & Xu, 2019). However, community college students have chosen online courses on a course-by-course basis by considering the suitability of the content area to the online context, difficulty of the course (with a greater difficulty calling for in-person instruction), and importance of the course (with greater importance weighing in favor of in-person; Jaggars, 2014). Undergraduates at a large research university made similar calculations, with in-person classes selected by students for the perceived beneficial learning affordances, including greater opportunities to learn from interaction with the instructor and peers (Fischer et al., 2020). Important from an equity standpoint, some students may not be able to attend higher education or may be limited to very slow progress through degree programs in the absence of online options and may not be able to choose optimally between online and in-person courses. However, there is little causal evidence in the higher education context that online learning opportunities increase access, especially for underrepresented student groups (with the exception of Goodman et al., 2019, studying the Georgia Institute of Technology's online master's degree in computer science).

Although both supply and demand for online courses have grown in higher education, the impact of online courses on performance outcomes has been mixed. Research has shown that undergraduate students generally performed worse in online compared to face-to-face classes when controlling for population differences (Alpert et al., 2016; Jaggars & Xu, 2010; Xu & Jaggars, 2011, 2013, 2014; Xu & Xu, 2019). Research also showed a withdrawal rate in online community college courses of 3% and 15% when compared to similar students in face-to-face classes (Xu & Jaggars, 2011, 2014). Comparing online and face-to-face courses at a large for-profit college, Bettinger et al. (2017) found a 0.44 point drop in course grade, a 0.33 SD decline; lower course grade in follow-on courses (i.e, the next course in the sequence) of −0.32 to −0.42 SD; and a 9% increase in the likelihood of dropping out for online students. A smaller grade penalty existed in research universities (Fischer et al., 2020). Additionally, students in online courses tended to fail to complete the course in greater numbers than did those in face-to-face courses (see, e.g., Alpert et al., 2016, finding 30% attrition in person and 46% online). Thus, to the extent that certain groups of students were more likely to attend online courses, they were disproportionately harmed by this grade and persistence penalty.

The performance decrement of online (versus face-to-face) classes has been significantly larger for students from disadvantaged backgrounds (Jaggars & Xu, 2010; Xu & Jaggars, 2011, 2013, 2014). In general, researchers have found that males, Black students, Hispanic students, and low-performing students had larger online performance gaps than did their counterparts (Figlio et al., 2010; Xu & Jaggars, 2014). Hart et al. (2018) used fixed-effects analyses to estimate performance differences in the California Community Colleges between online and face-to-face courses using data from 2008 to 2012. The researchers found that on average, students in the online courses had poorer outcomes with respect to course persistence, passing the course, and receiving an A or B in the course. Students were also more likely to repeat courses taken online (presumably to improve their grades), but were less likely to take the next course in a sequence of courses if the initial course was taken online. When the researchers examined performance differences across racial and ethnic groups, Asian students had much smaller performance gaps than did other groups—7.5 percentage points for Asian students, compared to 14.1 percentage points for White students, 15.3 percentage points for Hispanic students, and 16.5 percentage points for Black students. These patterns suggest that the achievement gaps seen in traditional face-to-face classrooms were not only replicated but exacerbated in the online setting.

An important caveat, however: although in the short-term student outcomes may be lower for students in online courses compared with face-to-face courses, some studies

community college students who take at least some online courses are more likely than those who take only traditional courses to earn an associate degree or to transfer to a four-year institution. Similarly, Fischer et al., (2019) found that online course enrollments were statistically significantly associated with slightly higher student graduation rates at a 4-year research institution (1.34% higher predicted probability of successful graduation within four years for each online course participation, increasing to 2.51% and 3.76% for five- and six-year rates). For the students who persist to a degree or successfully transfer, their goals for taking the online courses outweighed the lack of face-to-face benefits. Thus, the access that online courses afford students can have important long-term implications despite the short-term grade and course persistence challenges in the post-secondary environment.

Emergency distance learning

In March 2020, most undergraduate education moved courses online. This abrupt transition to distance learning and the larger environmental changes due to the pandemic brought new challenges for all students. While some colleges and universities returned to face-to-face courses, many students remained in online courses through the 2020–2021 academic year and for periods of the following year as necessitated by new variants and rising infection rates. This mass experiment in online learning had ripple effects; the Office for Civil Rights study of the disparate impacts of COVID-19 observed that the pandemic "has raised new barriers for many postsecondary students, with heightened impacts emerging for students of color, students with disabilities, and students who are caregivers, both for entry into higher education and for continuing and completing their studies" (U.S. Department of Education, 2021, p. iv). The challenges and opportunities presented in EDL were impacted by the additional stresses of the health and socioeconomic effects of the pandemic that disproportionately affected racial and ethnic minorities (Tai et al., 2021).

While impossible to disaggregate the effects of online learning, the pandemic, economic pressures, and racial unrest, higher education is facing reduced undergraduate enrollment. Undergraduate enrollment in fall 2020 declined by 2.5% from the fall of 2019 and fall 2021 declined an additional 2.7% (National Student Clearinghouse, 2022). The most severe decline in the fall of 2020 occurred at community colleges, where enrollment fell by more than 10%, historically Black colleges and universities, Minority Serving Institutions, and Tribal Colleges and Universities (U.S. Department of Education, 2021), suggesting that a disproportionate number of low income and minority students failed to begin or continue their postsecondary education. Under-enrollment appeared to be particularly high for

prior year (National Student Clearinghouse, 2022). Even more troubling from an equity standpoint, graduates at high-poverty high schools enrolling in college during the same period declined 32.6%, compared with a 16.4% decline for those in low-poverty schools.

Few reports on 2020–2021 achievement outcomes are available at the college level. Orlov et al. (2020) studied classes at 4 U.S. research institutions to compare spring 2020 (online) to fall and spring 2019 (in person). They looked at standardized assessments in seven economics courses and found that students performed substantially worse on average in spring 2020 compared to the prior periods. They found that the decline was shared across demographic groups. However, instructors with prior online teaching experience had student scores that were higher than those of instructors without such experience. Researchers found evidence that students in classes with planned peer interactions also benefited, compared to other classes without the planned interactions.

In one of the first experiments to come out of the pandemic, Kofoed et al. (2021) randomly placed West Point students into either online or in-person classes in the fall of 2020. The classes shared the same syllabus, graded events, homework assignments, and exams, and instructors teaching in both modes. Final grades for online students were 0.215 standard deviations below in-person students' grades, driven by the students with below-median academic ability. Online learning was much worse for male students, with female students having 0.051 standard deviations of a decrease online compared to 0.266 for male students. Faculty experience did not play a role in the differences. Students in the online course reported struggling to concentrate in class and feeling less connected to their instructors and peers, reflecting the difficulty in self-regulated learning and reduced interaction (see below, "Factors Impacting Equitable Access to Online Learning," for discussion of self-regulated learning and interaction). The West Point study indicated that the equity gap in online learning continued during the pandemic and will need to be addressed for this cohort of students going forward.

Research on online courses in elementary and secondary education

Ten years ago, there were few rigorous studies contrasting online and face-to-face learning in elementary and secondary school settings, and most studies largely dealt with older students (U.S. Department of Education, 2010). Although the knowledge

secondary, and even more so in elementary, education. The existing research on online learning in elementary and secondary education suggests similar themes to those reported in higher education contexts—there are inequities in how online courses are accessed and student outcomes.

Access—who takes online courses and why?

What did online course-taking look like at the K–12 level prior to the pandemic? For the most recent reported period (2016–2017), only 21% of public schools and 13% of private schools offered *any* courses entirely online, with a higher percentage of charter schools (30%) doing so compared to traditional public schools (20%; NCES, n.d.). Most of the schools offering courses online offered only one or a few courses, 26.6% offered less than half of all courses online, 8.7% more than half, and only 5.7% offered all courses online (data for 2015–2016; NCES, n.d.). Online courses were primarily available at high schools (57.5%) and middle schools (12.8%), with very few primary schools offering online courses (3.4%; NCES, n.d.). Secondary students attended both supplemental online classes and full-time online schools, whereas most elementary online programs were for full-time online students (Watson, 2007). Secondary students in online courses primarily spent 50–75% of their course time online but younger students often spent 15% or less of their course time online, relying on parents or learning coaches to facilitate their work (Watson, 2007).

The growth of online high school courses has been particularly noticeable, with the number of public high school students enrolled in an online course rising from 300,000 in 2004–2005 to 1.3 million in 2009–2010, and 2.7 million in 2014–2015 (NCES, n.d.). A report by the Digital Learning Collaborative (2020) reported 375,000 students in fully online schools for the 2018–2019 school year, less than 1% of all K–12 students in the United States. Several states require that high school students take at least one course online (Arkansas, Alabama, Florida, Michigan, and Alabama; cf. Morgan, 2015).

In the past, online courses were generally taken by secondary students because they offered instruction not otherwise available at the school, including Advanced Placement (AP); they met the needs of specific groups of students (e.g., competitive athletes); they permitted students who failed a course to take it again (e.g., credit recovery); or they reduced scheduling conflicts for students (Picciano et al., 2012). For schools with fewer resources, increasing course offerings, especially courses needed to attend college, could enhance both accessibility and equity. Online course offerings might allow students to access an enriching array of college preparatory courses that are unavailable at under-resourced schools or decrease the serious racial gaps in AP and dual enrollment attendance in high school (Xu et al., 2021). The reality of who

and upper-middle class (NCES, n.d.). Hardt et al. (2020) researched statewide student-level course data from Florida high schools, which have the largest virtual presence in the nation, and found that only 7% of high school students in 2013–2014 enrolled in online courses that were not available in a face-to-face option at their own high school. More concerning from an equity standpoint, however, is that the scholars found this use of online courses to supplement course offerings was more common among higher-achieving students, Asian students, more affluent students, and females. Students qualifying for free or reduced-price lunch, in special education, or designated as having limited English proficiency were all underrepresented in the online courses of this nature.

Underrepresented and low-income high school students have been most likely to use online courses for credit recovery, remediating failing grades (Rickles et al., 2016), and completing core requirements in academic subjects (Clements et al., 2015). In fact, credit recovery represents one of the fastest-growing areas of online K–12 education (NCES, n.d.). Fifteen percent of all high school students have participated in credit recovery, over 70% of which was done completely online (Rickles et al., 2016; Digital Learning Collaborative, 2020, estimating about 1,500,000 students took online credit recovery courses in 2018–2019). Students steered into online credit recovery courses are disproportionately underrepresented minorities (Rickles et al., 2016).

Performance—grades and graduation

Studies of online learning in the K–12 context are less clear-cut with respect to performance outcomes than studies in higher education, partially because K–12 studies do not involve randomization and thus researchers struggle to control for demographic features likely to confound the choice to attend courses online. In addition, studies are largely done with students taking classes from different teachers and, potentially, exposure to different curricula and pedagogy. Ultimately, though, the weight of the evidence matches that in higher education. Students generally perform −0.10 to −0.30 *SD* worse online compared to face-to-face classes when controlling for population differences (Ahn & McEachin, 2017; Fitzpatrick et al., 2020; Hart et al., 2018; Heissel, 2016; Means et al., 2014; Miron & Urschel, 2012), with at-risk and minority students suffering the largest performance gap (Hart et al., 2018; Woodworth et al., 2015). For example, a randomized control trial of 1,224 9th-grade students in online versus face-to-face credit recovery for at-risk urban students in summer (Heppen et al., 2017) found that the online students reported the course was more difficult ($d = 0.51$), was less likely to recover credit ($d = -0.35$), and scored lower on an algebra posttest ($d = -0.19$). These students were primarily African American and Hispanic.

et al. (2019), showing that Florida high school students were more likely to get a passing grade in the online course than in a face-to-face courses. Online credit recovery courses seemed to improve class passing and graduation rates. However, these courses may essentially be a second-status track to increase graduation rates without addressing the learning needs of the students being served (cf. Malkus, 2019). Hart et al. (2019) found that among both first-time and credit recovery students, those in online courses were more likely to pass the course than those taking the same class face-to-face. For more distal outcomes, first-time course-takers in online instruction had moderately negative outcomes, i.e., they were 2.6 percentage points less likely to graduate than those who took the course face-to-face. Online course-taking, on the other hand, was *positively* associated with downstream outcomes for credit-recovery students, who were 6.5 percentage points more likely to graduate when compared with face-to-face students of the same course, even after controlling for an extensive set of student and school characteristics (Hart et al., 2019). More study is needed to parse out the effects of these online credit recovery courses and their heterogeneous effects.

Emergency distance learning

In March 2020, most public and private schools in the United States physically closed through the end of the 2019–2020 school year, and many of the students transitioned to EDL. Different from traditional K–12 online learning, this was completely online, with students and teachers who had neither chosen nor prepared for the new mode and included even the youngest students in K–12 education (Vu et al., 2020). There is mounting evidence (Kuhfeld et al., 2020) that the changes wrought by the pandemic particularly hurt students of lower socio-economic status (Chetty et al., 2020) and of color (Tarasawa, 2020), widening preexisting disparities (U.S. Department of Education, 2021). In addition, any attempt to look at student achievement levels during this period is necessarily confounded with the (inequitable) impact of the concurrent pandemic, economic stress, and racial issues. Nonetheless, this evidence aligns with prior research findings of amplified equity gaps in online education, discussed above.

When looking at EDL for elementary and secondary students, we start with attendance —an early bellwether of downstream outcomes. Enrollment numbers and attendance figures were down in traditional public-school districts according to contemporary accounts (Economist, 2021). For example, California's K–12 public-school enrollment dropped by 2.6% in 2020–2021, about five times higher than recent annual rates of enrollment decline (California Department of Education, 2021). On the attendance side, in May 2020 Boston public schools reported at least 20% of their students had not logged into classes that month (Toness, 2020). There are some indications that a

schools, and homeschooling (Henderson et al., 2020), in part due to dissatisfaction with districts' responses to the pandemic. Much like in higher education, efforts to reengage with these students are needed if they have completely left the education system.

Reports also suggest that EDL lasted longer for some students than for others. For example, when 60% of students started the 2020–2021 academic year in fully remote classes (Dorn et al., 2020), students remaining in the online mode differed along socioeconomic and racial lines. Schools with higher percentages of people of color and low-income students were more likely to be fully remote (Kaufman & Diliberti, 2021). To the extent online learning is less effective, the impact of minority and low-income students staying online longer will have inequitable downstream effects.

The quality and amount of EDL also differed by demographics. Reported instructional time and coverage of curriculum were lower in schools that were fully remote during the 2020–2021 school year (Kaufman & Diliberti, 2021; Table 1). According to one report, only 60% of low-income students were regularly logging on for EDL, compared to 90% of high-income students (Dorn et al., 2020). Engagement rates also lagged in schools serving predominantly Black and Hispanic students, with only 60–70% logging into learning platforms regularly (Dorn et al., 2020). In another example of inequitable participation, fall 2020 data from a widespread online elementary math platform showed that student participation decreased by 16% for low-income students and only 2% for high-income students (Chetty et al., 2020).

Table 1. Reported live teacher contact over the prior 7 days.

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In the fall of 2020, NWEA released the first major assessment of K–12 learning during the pandemic (Kuhfeld et al., 2020). They found that reading scores for students in Grades 3–8 were similar to same-grade students in fall 2019, but math scores were about 5–10 percentile points lower than the prior year. The report noted, however, that student groups especially vulnerable to the impacts of the pandemic were more likely to be missing from the data and accordingly there was no report on the emerging racial and ethnic gaps and the reported numbers were underestimating the impact of the pandemic. Researchers analyzed a subset of NWEA test scores and found that the average student had lost a third of a year to a full year's worth of learning in reading and about three-quarters of a year to more than a year in math during the initial stages of the pandemic (Center for Research on Education Outcomes

grade-level peers would be expected to have learned (Dorn et al., 2020). Schools that served more than 50% minoritized students showed scores 59% of the historical average in math and 77% in reading. The learning loss through the end of the 2020–2021 school year was estimated to average five to nine months, with minoritized students six to twelve months less compared to four to eight months for White students, increasing existing achievement gaps by 15–20%. Fall 2020 Dynamic Indicators of Basic Early Literacy Skills (DIBELS) scores, a commonly used measure of early literacy skills, were also significantly lower than in prior years (Dorn et al., 2020). First-grade students were the most dramatically different from prior years, with an increase from 27% scoring well below benchmark in 2019 to 40% in 2020, and other grades were also well below historical benchmarks.

Spring 2021 results remained troubling: Kogan and Lavertu (2021) estimated the impact of the pandemic from March 2020 to spring 2021 in Ohio was approximately one-half to one year's worth of lost learning in math, with later grades having greater declines. Students overall declined between one-third and one-half of a year's worth of learning of English language arts, but historically underserved students (measured by race, income, homelessness, disability, and English learner status) experienced declines that were one and one-half to two times higher than their peers. The researchers noted that districts with fully remote instruction were negatively impacted up to three times more than districts that had in-person instruction for the majority of the school year (Kogan & Lavertu, 2021). Teachers reported having to serve an increasingly broad range of learning abilities within a single age-based class (Willemsen & Cohen, 2022). The pandemic caused greater disruption to students in the lower-achieving performance categories, widening existing inequalities.

Economic stress, health issues, and the emergency nature of the move to online learning during the pandemic were likely responsible for a great deal of the problems, but given what was known of online learning prior to the pandemic, we believe the online nature of learning played a role in the negative outcomes. EDL amplified existing achievement gaps, with students most at risk likely to be online longer, less engaged, and more negatively affected. However, knowing that EDL amplified existing online education equity issues for elementary, secondary, and postsecondary students is not enough. Researchers and educators need to understand the factors impacting equitable access in order to develop effective ways to address them.

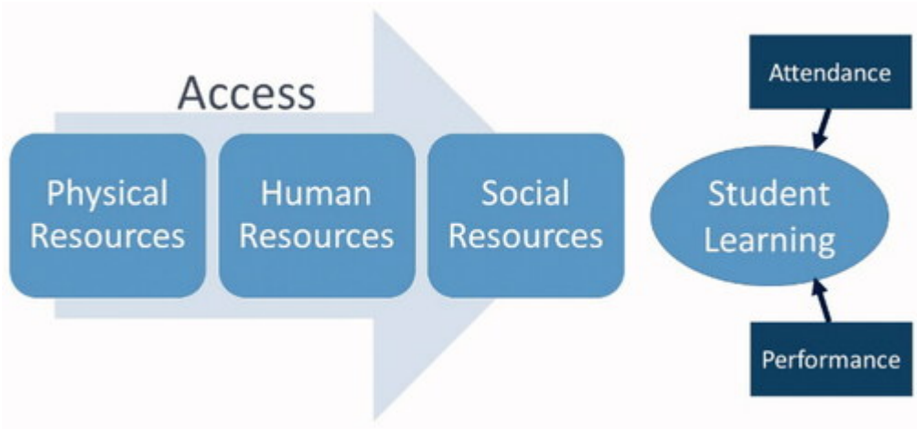
Factors impacting equitable access to online learning

paraphrase Kranzberg (1986), tools are neither good, nor bad, nor are they neutral, and "the same technology can have quite different results when introduced into different contexts or under different circumstances" (pp. 545–546). Tools do not simply facilitate preexisting actions but become part of the process of behavior (Vygotsky, 1981). Challenges arise in the context of online learning that may not be present or are less pronounced in face-to-face learning, but that must be addressed for equitable online learning (Greenhow et al., 2022/this issue), and online learning in the context of a pandemic further complicates the problem.

Given the fundamental nature of education and the almost universal move to EDL in the pandemic, we find past work specifically focused on technology and social inclusion compelling. Social inclusion goes beyond having adequate resources and instead strives for full participation by individuals, in this case within the realm of education and particularly online education (Warschauer, 2003). Equitable social inclusion means full participation regardless of economic, racial, or economic background.

Many early equity initiatives focused exclusively on access to physical devices and creating low-cost devices (e.g., Mitra, 1999). Sometimes hailed as groundbreaking contributions to equitable access, the actual long-term results of such projects are less clear, with many researchers, educators, and parents concerned that simply allowing children to use devices without supervision, instruction, or educational curriculum was ineffective and wasteful (Warschauer, 2003). Consistent with constructivist approaches that view learning as an internal mental process based on an individual's discovery of external phenomena (Piaget, 1970) and support the use of educational technology (Papert, 2020; Schank & Cleary, 1995), social inclusion recognizes the numerous resources necessary for full participation.

Warschauer's framework (2003) moves beyond a binary focus on access to physical resources and considers the ways in which differing levels and gradations of access contribute to social and economic stratification or inclusion. Differing access to online learning, particularly when it becomes the primary mode of education, contributes to stratification or inclusion that is in part reflected in student attendance and achievement outcomes. This social inclusion lens changes the focus from providing equipment and instead to ensuring the individual and social resources needed for meaningful educational opportunities. Physical, human (individual), and social (community) resources are necessary for full inclusion in, and access to, online learning (Figure 1).



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Physical resources—space, hardware, internet

Physical resources are a basic necessity for accessing online learning (National Academy of Education, 2020). Although by no means sufficient, they are a precursor to inclusion and the physical resources available to a student create constraints and affordances for their online learning (McGrenere & Ho, 2000; Wertsch, 1991). To effectively engage in online learning, students need access to appropriate hardware (e.g., Chromebooks and laptops), reliable and robust internet access, and a quiet environment in which to study. The need for digital devices and internet access to support online learning has been widely discussed under the umbrella of the "digital divide" by economists, researchers of educational technology, and educators alike.

Reports on the physical access divide vary, but all agree that there is a significant unmet need related to internet access. Pre-pandemic data shows that of the 51 million public K–12 students in the United States, approximately 1 million of them lacked access to the necessary digital devices, 5–6 million had insufficient internet, and 9 million lacked both devices and internet (Chandra et al., 2020). This divide is uneven: Only 18% of White households lacked broadband, compared to 26% of Hispanic, 30% of Black, and 35% of Native American students; 37% of students in rural communities compared to 25% in suburban households and 21% in urban areas lacked broadband (Chandra et al., 2020; see also Anderson & Kumar, 2019; Perrin & Turner, 2019). Students without broadband have a lower-than-average income and about a quarter qualify for food stamps (Chandra et al., 2020).

Additional Census details have shown that ownership of desktop, laptop, and tablet devices has declined, while smartphone ownership has increased. As of 2019, 62% of households with school-aged children had smartphones, compared to 24% with desktops, 44% with laptops, and 30% with tablets (NTIA, n.d.). Researchers found that

owned a smartphone (Perrin & Turner, 2019). Attending online courses via a smartphone is a significant disadvantage, and students who do so were less likely to stay engaged in online learning (Aguilar et al., 2020). Smartphones can be incompatible with learning systems and applications; difficult to use for reading, typing, and producing assignments because of their small screens and inadequate keyboards; and potentially more distracting due to the heightened presence of games and social media.

Human resources—literacy, education, and self-regulated learning

Human, or individual, resources that are needed for successful online learning include literacy (both digital and more traditional reading and writing skills), prior education, and self-regulated learning skills (Means et al., 2014). Gaps in literacy based on race, ethnicity, and socioeconomic status (see, e.g., Hemphill & Vanneman, 2011, reporting on racial and ethnic achievement gaps in the National Assessment of Educational Progress) and educational attainment based on these demographics are well documented (e.g., graduation rates of 93% for Asian students, 89% for White students, 82% for Hispanic students, 80% for Black students, and 74% for Indigenous students; Irwin et al., 2021).

Beyond literacy and prior education, online education requires students to assume greater responsibility for the learning process when compared to face-to-face classes. Lacking an in-person meeting with instructor support to navigate the learning demands, online classes require greater self-regulated learning from students (Bambara et al., 2009; Kizilcec et al., 2017; Milligan & Littlejohn, 2014). Students must navigate information-rich environments and independently determine when they will access the course content (including lectures) and complete assignments; learn course material without immediate access to instructors or peers when questions arise; deal with technical issues and navigate online platforms; and find motivation despite the lack of the social community often found with an in-person environment (Bambara et al., 2009; Roll & Winne, 2015; Tullis, 2020).

Students' level of self-regulation and preparedness for the self-directed learning required by most online courses varies (Derrick et al., 2007; Xu & Xu, 2019). For example, Reio and Davis (2005), found a developmental trend with older students showing higher self-directed learning readiness scores than younger ones, with interaction with gender (female students had higher scores than males) for the 14–20 year age group (see also Slater et al., 2017, gender and age). Other researchers have suggested that students with lower prior academic achievement or less academic preparation exhibit lower levels of self-regulated learning (see Spencer & Temple, 2021, lower prior performance; Williams & Hellman, 2004, first-generation students).

not yet prepared for successful online learning and needing scaffolding for the requisite self-direction and regulation.

Social resources—community, teachers, peers

Social, or community, resources, such as teachers, peers, and parents, provide the information, influence, and support needed for successful online learning. Parents and siblings can help troubleshoot technology issues, such as connecting to a printer or the internet, and emotional support to help support students' persistence. Adult availability during online learning and experience navigating the U.S. school system provide additional resources to students. Teachers tend to be responsible for guiding online learning, but require specific training in how to effectively teach and support learning in online environments (Ertmer & Ottenbreit-Leftwich, 2010). However, teachers have received insufficient education to prepare them to use technology to support meaningful online learning (Ertmer & Ottenbreit-Leftwich, 2010), and prior to 2020 most teachers had never taught online (Howard et al., 2021).

Classrooms themselves become one of a student's communities and provide resources to support learning through informal interaction, provision of information, and collaborative work. Online learning is often hindered, however, by the lack of interpersonal interaction (Bambara et al., 2009; Xu & Jaggars, 2014). Owing to the physical separation between students and instructors and often asynchronous course design, students in online courses persistently report feelings of disconnectedness, distraction, and lack of personal attention, which have negative effects on course persistence and learning performance (Arbaugh, 2001; Jaggars & Xu, 2016; Means et al., 2014; Picciano, 2019). In addition, challenges in implementing collaborative work online can diminish opportunities for critical thinking, problem-solving, analysis, integration, and deeper understanding of the material that such collaboration often brings (e.g., Friesen & Kuskis, 2013). EDL in the context of the ongoing quarantine and stay-at-home orders was occurring during an already extremely isolated context, possibly increasing students' need for community. Having conceptualized the equity issues in online education, prior to the pandemic, next we use Warschauer's (2003) framework to discuss the impact of the pandemic on equitable online learning, interventions or ways of reducing inequity in online learning, and directions for future research.

Factors creating inequitable access during the pandemic and proposed responses

At a minimum, to have a chance for successful online learning students need a reliable internet-enabled computer, a physical learning space, and a distraction-free environment for academic work. Finding an appropriate physical space for learning at home, free of noise or distraction, is difficult for disadvantaged students. Only one in three families reported that their children always had a place free of distraction for remote learning (Aguilar et al., 2020). Further, most college students were forced to move home during the pandemic (Fry et al., 2020). This need for physical space proved to be a key physical barrier to students' inclusion in EDL. Instead, they were faced with distractions and interruptions while attending an online class or doing homework—some even report working in closets and bathrooms. Other physical resources noted by Squire (2022) that were inequitably distributed included peripherals, such as a printer, and supplies such as paper.

During the pandemic, progress has been made on closing the hardware portion of the digital divide at the elementary and secondary level, with 92% of households with K–12 students always or usually having access to a device for learning and 91% having internet access (U.S. Census Bureau, 2021). Prior to 2020, many schools had already rolled out one-to-one device programs or had purchased classroom sets of devices that could be quickly repurposed. Another report estimates that as of December 2020, schools had closed 40% to 60% of the device divide and 20% to 40% of the K–12 connectivity divide (Chandra et al., 2020). However, a majority of the solutions deployed during the pandemic have been short-term stop-gap measures, with 75% of the efforts due to expire in the near term (one to three years; Chandra et al., 2020; Herold, 2017). Long-term funding for device replacement is needed to ensure future students have the same access to devices.

The internet divide persists. Black (85%) and Hispanic (92%) households with school-aged children compared to White (93%) and Asian (94%) households are less likely to have reliable access to digital devices and less likely to have reliable access to the internet (84%, 89%, 93%, and 93%, respectively; U.S. Census Bureau, 2021). One survey found that about half of those families in the bottom 20% of income still lack the necessary technology compared to 10% of families in the top 20% of income, and the gap between Hispanic and non-Hispanic students at the same income level is as high as 20 percentage points (Aguilar et al., 2020). Lack of access is especially affecting students with Spanish speakers at home; Census data show that internet adoption rates in households where adult members speak only Spanish are lower than those in households where other languages are spoken (U.S. Census Bureau, 2021). Undergraduates also report barriers to equitable access such as the lack of consistent physical resources (one in six experienced frequent issues, Means & Neisler, 2021).

of Black students and 12% of White students, and 24% of low-income students compared to 12% of high-income students (Means & Neisler, 2021).

Why does this access to physical resources matter? In one study of nearly 10,000 elementary school parents in spring 2020, researchers found that students in households with less than one device per child scored 0.13 to 0.32 *SD* lower on engagement in virtual learning. Students with access to high-speed internet were 0.32 *SD* higher than students without high-speed access to complete assignments. These differences were found even after controlling for parental educational attainment, family income, family economic insecurity (as measured by income loss during the pandemic), and food insecurity (as measured by student enrollment in the school's free or reduced-price lunch program; Domina et al., 2021). Given engagement in school can be seen as an initial step toward academic success, correlating with grade point averages (Carini et al., 2006) and graduation (Rumberger & Lim, 2008), this is an important finding.

Continued efforts to ensure that students at all levels and in all demographics have access to the necessary hardware, reliable and robust internet, and physical spaces in which to study remain a national priority. Sustainable, cost-effective solutions are greatly needed because even beyond the pandemic, online learning will be one component of social inclusion that should be available to students regardless of their race, ethnicity, or income levels. Schools will need to budget for school-provided devices (including upkeep and replacement). Efforts to provide universal broadband access, increased provision of quality learning spaces, and childcare resources are among the initiatives needed to improve equitable access to physical resources for online learning. In addition, research is needed to discern the most important aspects of physical resource access and student online learning outcomes, with a particular emphasis on minoritized and under-resourced groups.

Human resources—literacy, education and self-regulated learning

Scaffolding self-regulated learning can be a valuable tool for improving equity online (Broadbent & Poon, 2015). Scaffolding can take various forms, including innate course structure (a clear and consistent schedule, such as reading quizzes every Wednesday and discussion prompts every Friday; Collins et al., 1989). Strategies suggested in the literature include chunking assignments into smaller parts, providing pacing support, and monitoring engagement with instructional materials (Carter et al., 2020). Instructors can also embed support for good study skills. For example, they can force more spaced studying by setting mini-deadlines for chunks of larger projects or having frequent quizzes (or reading responses) to incentivize staying current in the class reading. Weekly reminders of the deadlines and assignments can help students keep

appropriate for their course content, student profiles, and other contextual considerations. Indeed, different profiles of students have been shown to benefit from different types of support (Martin & Borup, 2022/this issue), with students who were underperforming benefitting the most from tools to help them plan their study behaviors and students experiencing academic difficulty benefiting from tools to help them prepare for exams (Brown et al., 2017; see also discussion in Bernacki et al., 2020).

As U.S. education moves forward, online instructors need training and time to build in support and scaffolding to ensure that all learners can be successful in courses, regardless of their demographics. The research community could provide guidance by expanding research on specific self-regulated learning interventions that improve equitable outcomes and are scalable and replicable since many of the current promising studies have required intense time commitments to customize the intervention for particular contexts (see, for example, the work done at Wake Tech Community College in its Project COMPASS, Carrell & Kurlaender, 2020; Chen et al., 2017). In particular, we need interventionist research on self-regulated learning in the K–12 environment, which could include the strategies used in the Project COMPASS and Carrell and Kurlaender interventions at the community college level. A combination of relatively simple strategies could build support for students such as providing synchronous orientation at the beginning of the online course, creating a custom welcome and orientation video on the front page of the course, instructors sending positive emails to students regularly, weekly reminders of what is coming next, ensuring the course includes images and examples of a variety of demographic groups, and other best practices suggested in online course rubrics that have not actually been tested (Xu et al., 2020).

Social resources—community, teachers, peers, and parents

The lack of social resources necessary for successful online learning is taking a toll on families and students. A large body of sociological research (e.g., Coleman, 1990) indicates that social capital often helps people navigate times of national disaster and crisis. Families need social resources to be successful. During the pandemic, many parents turned to the internet for online learning resources, as shown by a review of nationwide internet search activity. By April 2020, the activity relating to school- and parent-centered online learning resources had roughly doubled relative to pre-pandemic levels (Bacher-Hicks et al., 2020). But once again, this marshaling of resources is not equitably spread. Instead, portions of the county with higher income levels, better internet access, and fewer rural schools saw substantially larger increases in search intensity (Bacher-Hicks et al., 2020). This online search intensity

more affluent, White parents to compensate for lost in-person class time and is likely to lead to similarly unequal learning levels as seen in summer learning. In a preview of likely downstream effects, researchers found that exposure to more diverse socioemotional and academic learning activities and families' social connection to others predicted higher levels of engagement in online classes during the pandemic (Domina et al., 2021). Community outreach efforts to provide parents with the resources to navigate through available support options, coupled with supplemental community spaces to support and mentor students, are two possible ways to reduce the inequities in social resources. However, efforts of this type provide only limited relief against systemic issues that reduce some families' social capital.

Public education is one source of support that can provide necessary social resources. However, the education system is stretched and was unprepared for emergency online learning. Teacher preparation for online courses and the use of technology in pedagogically sound, research-based ways is a significant social-resource challenge to high-quality online education (Chandra et al., 2020; Ertmer & Ottenbreit-Leftwich, 2010; see also Archambault et al., 2022/this issue). Teachers—and students—were not prepared for full-time online learning. For example, many college instructors lacked training on using the technology underpinning online instruction (Brooks & Grajek, 2020). Community colleges may have had some advantages because online learning was more prevalent at these broad-access institutions than at 4-year colleges (Hart et al., 2021). Nonetheless, even in the California Community Colleges, which had a strong online presence, only 21% of courses were taught online prior to the pandemic (Hart et al., 2021).

In EDL, college instructors reduced the quality of their pedagogical practices, becoming less supportive and more detached, especially if the instructor reported lower self-efficacy related to online practices (Rutherford et al., 2021). The lack of training on digital tools is a "significant" or "extremely significant" barrier to using them (Klein, 2019). Teachers who had not previously taught online (the large majority of teachers, see Bartlett et al., 2020) were abruptly placed into a situation where they had to make online learning work with little time to adapt.

In the midst of a crisis (or, indeed, multiple crises), teachers had to create online materials, ensure everyone had the necessary devices and internet, and make sure that they (and students) understood how to post and access educational resources ranging from worksheets to videos. Students entered the classroom with different initial competencies (e.g., different levels of content knowledge, technology skills) and resources. Educators then needed to differentiate and address varying levels of access, significant logistical, financial, and even emotional capacity, and the very real trauma

daily instructional minutes (from 247 min per day to 91 min in spring 2020), replaced by increased planning, paperwork, and interactions with colleagues and parents (Jones et al., 2021). Our education system also provides a number of social supports, such as meals, social service referrals, and mental health care, and teachers were often on the front line of efforts to ensure that students and their families were receiving basic needs.

Few families have a stay-at-home, non-working adult who can step into the shoes of a professional teacher and fill that role on a daily basis (see discussion in Squire, 2022). It is not surprising, then, that 20% of secondary school students reported that not having an adult who can help them with schoolwork was an obstacle to their online learning (YouthTruth, 2021). In an April 2021 Pew survey, 62% of parents reported that K–12 online instruction had gone very or somewhat well, but 30% of parents said they have had a very or somewhat difficult time helping their children navigate online learning (McClain et al., 2021), with more rural and urban residents than suburban, and those with lower and middle incomes, than high incomes reporting greater difficulty. This inability to help with schoolwork or navigating institutions and resources may arise because of the parents' own educational level, digital literacy, or simply time constraints. In Los Angeles, for example, researchers found that about half of the parents in the study had not completed high school (Aguilar et al., 2020). They also found that despite regularly personally using the internet (likely on smartphones), they were less familiar with devices, dealing with internet connectivity issues, and accessing and monitoring the use of the multiple educational platforms required for emergency distance learning. In fact, one-third of the parents reported never having accessed the educational platforms that their children used for online learning. These students were isolated at home and in communities without the support of in-person teachers, librarians, tutors, and other social resources to navigate the educational and digital environments.

Peers provide another layer of social resources and support, but online classes significantly reduce opportunities for casual resource sharing and interaction (Broadbent & Poon, 2015). A national probability-based sample of undergraduates in spring 2020 found that students struggled with motivation (79%) and lack of interaction with instructors and peers, with students of color (particularly Hispanic students) and those of lower socio-economic status experiencing greater challenges than their white or more affluent peers (Means & Neisler, 2021). However, when instructors used quality online practices, student satisfaction was higher compared to other online courses without such practices (Means & Neisler, 2021). Researchers have proposed a number of ways to strengthen interaction in a fully online course, including

providing synchronous online discussion sessions to improve instructor-student interaction by mimicking traditional classroom interactions (Means et al., 2010). Interviews with online students and instructors have indicated strategies that enhance social interactions not only provide opportunities for instructors to offer academic support to students and for students to learn from each other but also—maybe more importantly—they help to create a sense of community and belonging in a virtual learning environment (Kear et al., 2014; Shieh et al., 2008).

Evidence suggests that intentionally increasing interaction improves student learning. Cung et al. (2018) found that providing optional in-person meeting hours and frequent instructor email activity to the whole class in a fully online pre-calculus course at a public university increased final exam scores by 0.22 standard deviations and improved passing rates by 19 percentage points. Conklin and Dikkers (2021) discussed the efforts of university instructors to maintain a social presence in the transition online at the beginning of the pandemic. Undergraduates reported that classes successful in keeping them in touch with their instructor, course content, and peers typically intentionally developed connectedness, had responsive instructors who coached students in the successful course navigation, used online learning best practices such as clear course organization (supporting self-regulated learning), and had empathic course facilitation (Tate et al., in press). A portion of Chicago Public School teachers, particularly Black and Latinx educators, reported developing *improved* relationships with students through increased individualized attention and emotional concern for their students, developing deeper and more holistic understandings of their students, and providing a diversity of ways for students to engage (Tackie, 2022). However, interaction during the pandemic may have prioritized instructor-student interaction over peer interaction, perhaps in part in order to prioritize student flexibility and access (Rutherford et al., 2021). Shea et al. (2022/this issue) elaborated on the various types of interactions espoused by the Community of Inquiry Framework (i.e., cognitive, social, and teaching presence). Research in this area should focus on replicable, scalable interventions that online instructors can adopt to increase interaction at both the instructor and peer levels, particularly at the K–12 level.

Conclusions

Equitable learning occurs when every learner belongs, contributes, and thrives, regardless of race/ethnicity or socio-economic status. Differential access to the physical, human, and social resources needed for digital learning has long exacerbated social and educational gaps in U.S. society. This situation has without a doubt been

access to digital devices and the internet during their K–12 careers have GPAs about 0.4 lower than students with such access, leading to 4–6% lower expected annual income and a $22–33 billion annual GDP loss (Chandra et al., 2020). The pandemic digital divide could lead to an average of 7–14 months of learning loss, an additional 232,000 high school students dropping out, and an annual earnings deficit of $110 billion (Chandra et al., 2020), and these estimates were before variants and insufficient levels of vaccination allowed for subsequent waves of infection that lengthened the pandemic and online learning periods. These stunning losses make clear that more equitable access to the physical, human, and social resources needed for effective online learning are critical elements of a just society. The education system will need to address the gap in enrollment or upstream gaps will be worsened. The United States needs new ways of not only attracting students to pursue undergraduate degrees but also remediating the disparate impact of the pandemic on health and economics in order to allow students to pursue their education.

However, equity in education is not fixed and efforts to improve equity more generally have shown significant progress over relatively short periods of time (OECD, 2018). The influence of socio-economic status on student performance can be reduced with the right policies and practices, though other inequalities have been more persistent (e.g., gender, immigrant background; OECD, 2018). Sustainable access to physical resources must be prioritized, including both the replacement of hardware over its lifetime and access to high-speed internet. Just as a society long ago recognized that telephone service was an essential commodity of 20th-century life, it must recognize that broadband access is similarly needed for full participation in 21st-century life. A number of initiatives are underway, at both the federal and state level, to ensure affordable broadband access throughout the country, and they deserve our energetic support.

There is no putting the genie of online learning back in the bottle. We do not agree with the naive techno-optimists, who envision a rosy future of inexpensive and highly effective online courses rapidly replacing face-to-face instruction across the country. But we do recognize that online learning options are likely to grow in both K–12 and higher education. Due to emergency remote learning, many instructors now have experience in the medium. There will also be greater use of online tools, such as learning management systems, within face-to-face classes because instructors are now more familiar with their use. For these reasons, strengthening the human and social resources as suggested above to enable better online learning will be more important than ever.

online learning, particularly during the pandemic, we are heartened by the many assets students bring to education. For example, first-generation students bring the assets of their experience, their self-reliance and independence, their strategic thinking, and problem-solving skills to navigating online learning (Hands, 2020). Teachers also play a key role in mitigating the inequity in online education. One possible starting point is making sure they understand any digital divide concerns in their student population (see, e.g., Aguilar's [2020] survey and interview protocols). Increased attention to supporting students' self-regulation and autonomous learning skills (Bambara et al., 2009; Kizilcec et al., 2017; Milligan & Littlejohn, 2014) as described above will have a positive impact on their lifelong learning opportunities. More attention will need to be paid to online learning developments that scaffold and support the development of these skills, rather than assume them (Martin & Borup, 2022/this issue). Similarly, approaches to increasing interaction and integrating more effective group work and collaboration in online environments should be both a pedagogical and research priority (Shea et al., 2022/this issue). Fortunately, the rapid development of communication technologies, including automated tools for scaffolding text, audio, and video interaction, can assist this effort. Finally, we note that this article has not addressed a number of particular demographics with extremely interesting and relevant equitable issues relating to online learning—particularly students with disabilities, gifted students, homeless students, and English learners. Researchers and educators alike must work to ensure equitable online learning for these populations as well.

With an eye on the physical, human, and social resources students at all levels of education need, the U.S. education system can not only improve online learning but also positively affect the broader educational environment, which with growing frequency makes use of online resources, and thus help the nation tackle educational underachievement and inequity. As the pandemic has made abundantly clear, this must be a national educational imperative.

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